

Raw Materials Management

Clemens Mann, HMC/CTS/MT

1. THE NECESSITY of Raw Materials management	222
2. “Holderbanks” SYSTEM OF RAW MATERIALS Management	223
2.1 Block model (CADE).....	223
2.2 Quarry Scheduling Optimisation (QSO).....	224
2.3 Quarry Engineering and Design (QED)	225
2.4 Production Scheduling (QuarryMaster).....	228
2.5 Applicability	228
3. COST EFFECTIVENESS	229

SUMMARY

The securing of raw materials, and their optimum utilisation, are essential factors for our industry, and they represent strategic competitive advantages. It is therefore necessary to have an effective and efficient system for the management of raw materials.

The general objectives of the management of raw materials are to ensure a continuous supply of the required raw materials at lowest possible costs and over the longest possible lifetime.

More than 20 years ago, "Holderbank" commenced developing a computer-aided system for this task, which consists of four main elements:

- 1) inventory of the raw material resources using a block model of the deposit(s) (CADE),
- 2) strategic long-term planning for optimum utilisation of raw materials (QSO-Expert),
- 3) quarry design and visualisation (QED) and
- 4) daily production scheduling (QuarryMaster).

"Holderbank" now possess a complete cement specific planning system, ranging from exploration to excavation, which has since been accepted as a high level tool in the industry.

The assessments carried out by "Holderbank" resulted in total yearly savings of more than 100'000 to over 1 million USD . This corresponds to savings of about 0.1 to 0.3 USD/t raw meal. This result was achieved by reducing the waste removal and the costs of correctives, and by increasing kiln OEE with a more uniform raw mix composition.

1. THE NECESSITY OF RAW MATERIALS MANAGEMENT

Raw materials are essential for our core business activities: production of cement and aggregates production, and even though they may represent a relatively small part of the total cement production cost, they can have a significant influence on the production cost and product quality. Another important factor is that the raw materials are not renewable, and new, suitable deposits are of limited availability. Therefore, securing of raw materials supply and their optimum utilisation are of essential for our industry, and offer a strategic competitive advantage. Without prudent, forward-looking planning, not only the profitability, but also the medium and long-term position of a cement manufacturer are placed at risk.

Raw material planning itself is exposed to continuously increasing requirements. The cement industry has now attained such a level of complexity where cost-effective planning and production is no longer possible without the use of computerised tools.

The increasing complexity in the field of securing and providing raw materials for cement is caused largely by the following factors:

- ◆ higher raw material demand by larger kiln capacities, with
- ◆ ever stricter quality specifications for raw mix composition
- ◆ more complex raw mix compositions (alternative raw materials and fuels)
- ◆ greatly increasing environmental regulations,
- ◆ continuously rising costs, and
- ◆ growing number of cement types and rapidly changing product specifications.

All of which necessitate the accurate evaluation of the deposit and reliable planning of the exploitation. Because of the large amount of data from exploration and production, which must be processed continuously, and the large number of requirements and constraints which must be taken into account, computerised tools are essential.

For these reasons, "Holderbank" started to develop and apply a computer-aided system for the management of raw materials more than 20 years ago. Deposit modelling systems were introduced in 1977, followed by QSO (quarry scheduling optimisation) in 1982. The latest development in this system is QuarryMaster launched in 1998, which is a tool for daily production scheduling.

2. "HOLDERBANKS" SYSTEM OF RAW MATERIALS MANAGEMENT

In order to fulfill the objectives

- of securing a constant and continuous supply of raw materials for the plant, and at the same time
- the cost-effective utilisation of the available raw materials, i.e. with the lowest possible costs over the longest possible life

in the best possible way, the "Holderbank" system consists of four main elements:

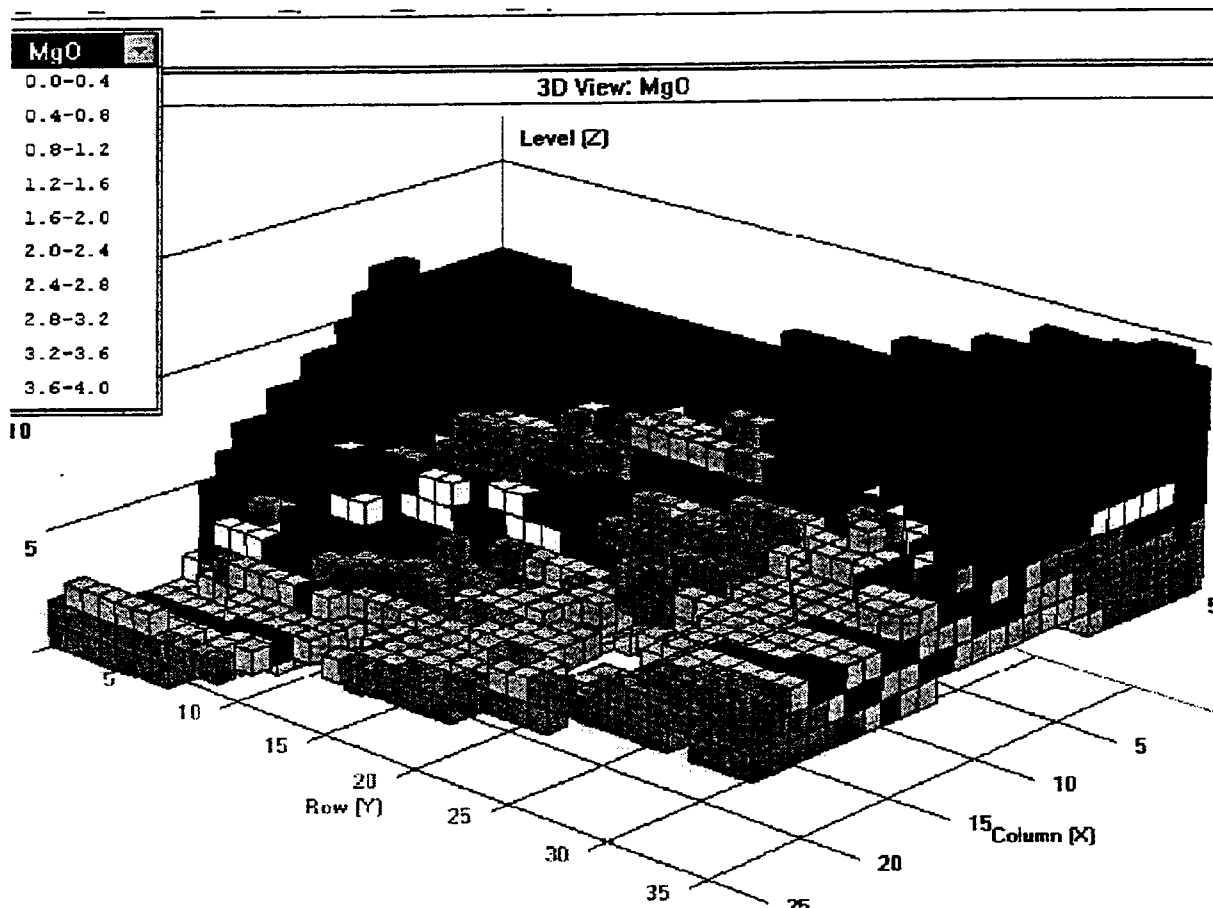
- an accurate inventory of the raw material resources using a model of the deposit (CADE),
- strategic medium and long-term plan for optimum raw material utilisation (QSO-Expert),
- quarry design and visualisation of quarry development (QED) and
- daily production planning (QuarryMaster).

The gradual development of combined application of the modules, has also lead to an array of instruments which provide efficient and optimum solutions to the problems listed above, ranging from strategic long-term planning to daily production planning. The most frequent questions about the characteristics and benefits of the most important modules will be dealt with in the following sections.

2.1 Block model (CADE)

The object of calculating deposit or block models is to obtain an objective, reliable, and reproducible description of the deposit. A block model is a complete three-dimensional description of a deposit (Fig. 1). To calculate the model, the deposit is subdivided into a large number of small blocks. Each block represents a quantity of quarried material corresponding to a week or a month's production. Based on drillings and other exploration data, interpolation methods are used to assign the contents and other parameters to each block. In other words, a variety of information such as drill results, geological investigations, geochemical and geophysical results, etc., are converted into the best possible consistent description of the deposit.

Fig. 1 Block model of a clay deposit.



The resulting block model is an accurate inventory of the deposit, which describes the expected quality and quantity for each point (block). It now represents one of the most effective instruments for raw material evaluation.

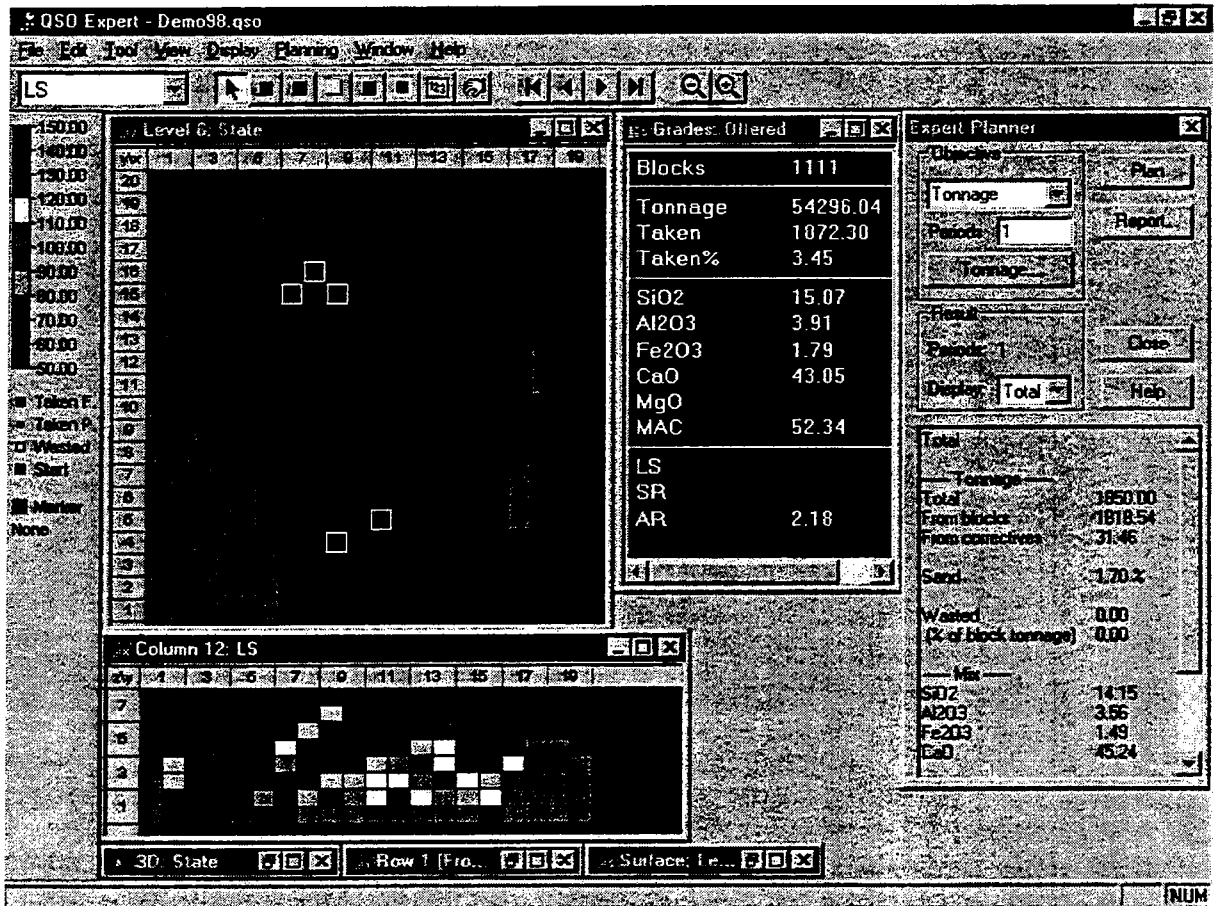
2.2 Quarry Scheduling Optimisation (QSO)

The block model only describes the state of the deposit and, in particular, the raw material reserves. The next question is: how this given deposit may be used in the best possible way? To answer this question, QSO is used to calculate geological and raw mix reserves whilst considering different raw mix requirements and different corrective materials. In this way, the influence of different raw mix compositions on the utilisation of the deposit can be investigated, and finally long and medium-term exploitation plans can be developed. QSO uses in-built operations research techniques to determine the optimum solution. For the optimisation procedure, QSO considers not only the chemical raw mix requirements, but also mining rules, which are specified by the user. This results in chemically correct and technically feasible mine plans.

The first practical application for a "Holderbank" group company took place as early as 1982. The ideas developed at that time, and the results achieved, were encouraging and showed the direction to be followed. The application of these methods was, however, relatively expensive as it required large computers and well-trained personnel. Due to the fact that QSO is a planning tool frequently used on-site, the breakthrough happened in 1985

because of the wider spread use of PC's. QSO is now in its fourth generation, which is known as QSO-Expert for Windows.

Fig. 2 Example of a typical QSO-Expert screen.

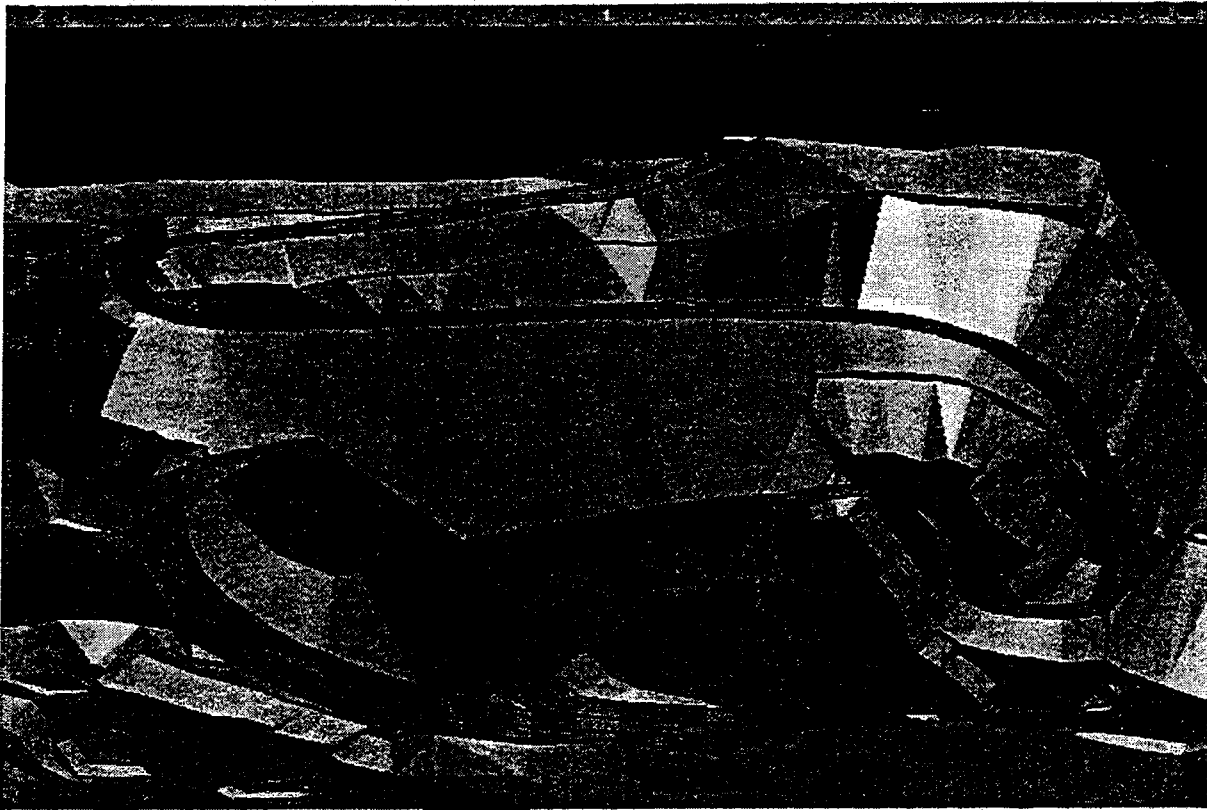


2.3 Quarry Engineering and Design (QED)

In addition to the optimum raw mix composition, some technical design features for the quarry have to be determined. These are bench height, berm width, general mining strategy (e.g. top to bottom) and mining method (e.g. truck haulage, in-pit crushing or glory hole system).

QED also includes the integration of these technical features in the quarry plans, such as haul roads, ramps, dewatering ponds, waste dumps etc. In this way, the optimum long-term mining strategy is transferred into detailed technical quarry plans.

Fig. 3 Haul road design for a quarry.

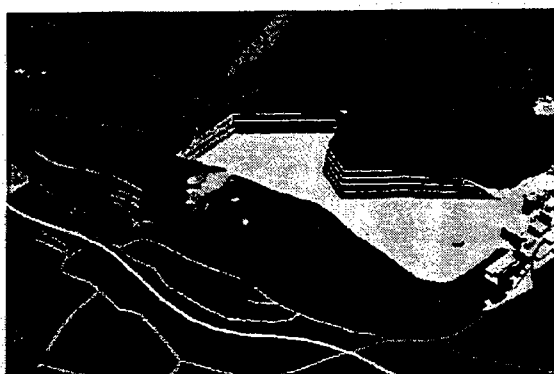


In order to obtain a mining permit for a deposit, it is of utmost importance to show what the future appearance of the quarry will be. Therefore, mine plans representing the future quarry development are elaborated with QSO. These plans are then transformed into photo-realistic 3D-views using the technique of digital terrain modelling, whereby the appearance of the quarry at any given time can be realistically shown, refer the proposed quarrying plan (Fig. 4). For this task, special commercial CAD programmes and animation software are used.

With such detailed representations of the quarry, it is possible for the authorities, and more important for the public, to visualise the quarry development in an easily understandable way.

The same technique can also be used to analyse the visual impact of the quarry on the surroundings. The aim of such a visibility analysis is to achieve the increasing objective of blending the quarry as inconspicuously as possible into the landscape.

Fig. 4 Three-dimensional representation of the development of a quarry.



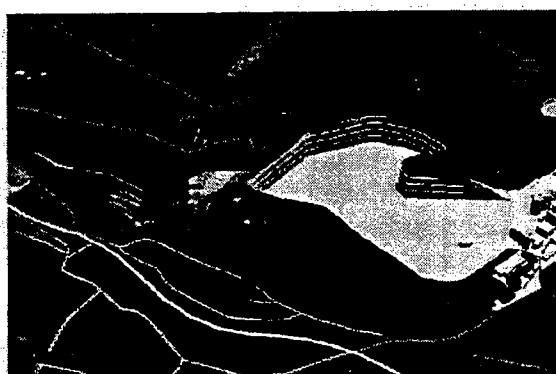
Variante "Mormont Nord-Est" en 2045



Variante "Mormont Nord-Ouest" en 2045



Variante "Canyon" en 2045



Variante "Sommet du Mormont" en 2045

2.4 Production Scheduling (QuarryMaster)

The most uniform raw mix with the correct chemical composition is essential for an efficient plant operation and a high product quality. Using QSO, the optimum long-term strategy is determined and long and medium-term mine plans are developed. The shortest time is normally not less than one year due to the size of the blocks. However, for daily operations, it is necessary that production for a much shorter period of time fulfills the process requirements. That means every preblending pile, respectively the quarry production for every day, has to be within the limits. For this very purpose QuarryMaster was developed. It is a tool for daily or weekly production planning in the quarry.

QuarryMaster assists the quarry manager in deciding how many tons have to be mined from which blast in order to produce the correct raw mix, with the given equipment and manpower whilst staying in line with the long-term mine plan. QuarryMaster is based on a digital terrain model of the quarry, which means the quarry topography can be represented in all necessary details.

Short-term planning or production scheduling requires more accurate data with respect to the raw material situation. The average values from the block model, which are adequate for long and medium-term planning, are not sufficiently reliable. The daily fluctuations require special consideration, which now necessitate a more detailed database. Therefore, analyses data from blasthole dust, sampling stations, or cross-belt analysers are used for production scheduling.

QuarryMaster is an important tool for quality control. In fact, it represents the first step in a modern production process, as the raw mix quality must be planned at the very beginning, which means right in the quarry. There is a strong interaction between production scheduling and quality control, and the use of QuarryMaster ensures the link between planning and control.

Taken as a whole, it provides uninterrupted co-ordination from deposit evaluation right up to excavation planning, and production control and quality checking. Nowadays, this is a precondition to ensure the required quality and quantity of a product over a fairly long period, with lowest possible daily fluctuations. At the same time best possible use of the available raw material reserves is made.

2.5 Applicability

From a mathematical point of view, the calculation of optimum excavation plans is a demanding task. Calculation of the block models is also a computationally intensive undertaking, which is not at all simple. Twenty years ago, it was necessary to have large and expensive scientific computers and well-trained personnel.

Nowadays, with the powerful low-cost PC's, most of these tasks can be carried out in close proximity to the operation by the quarry personnel themselves. The drill hole databank, the block model, and the excavation planning are prepared by experts, and QSO-Expert and the QuarryMaster are implemented on-site. After a relatively short training phase (1 – 2 weeks) the quarry personnel can operate and use the tools to their full extent.

It is important to remember that in addition to the high level of appropriate software products, one of the success factors in implementing raw material planning systems is experience. Proof of "Holderbank's" expertise in this field is given with the successful completion of more than 150 projects, which have been carried out using computer aided raw material planning. The present software system can be described as having been developed "by a cement manufacturer for a cement manufacturer".

3. COST EFFECTIVENESS

Under the continuously mounting pressure of costs, the question of cost savings using computer-aided raw material planning arises with increasing regularity. In addition to the indirect benefits - such as, better and more reliable knowledge about the deposit, rapid and optimum results in evaluation and planning, quantification of risks, evaluation of different scenarios - the main interest lies in the measurable savings in production costs. Estimates carried out by "Holderbank" in the past showed potential annual savings of up to a few hundred thousand USD in various situations. Relative to one tonne of raw mix this normally means cost savings of 10 - 30 cents. These were achieved by reductions in the quantity of overburden and in the costs of correctives consumption, and through increased OEE of the kiln because of a more uniform raw mix composition.

The costs of implementing a computer-aided raw materials management programme amount to between USD 100,000-200,000. Bearing in mind the above mentioned cost savings of 10-30c/tonne of raw material consumed, a payback period of 1-2 years more than justifies the initial investment. So far, over 150 international projects have been carried out for cement lime and aggregate producers all over the world.

